Spring 2022 EE214 Experiment 1
Diodes and Rectifiers

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Contents

1 Introduction

In this experiment , characteristics of different diodes ,and rectifiers are investigated. First the i-v characteristics of 3 different diodes are expected to be observed. Then, the behavior of the half wave is expected to be experimented. Lastly, observations are made on clamper and zener regulator circuits. The results of the experimentation is presented in this document.

2 Experimental Results and Discussion

The results of the experiment are discussed in following steps.

2.1 Step 1

In this step, the circuit schematic given in Figure 1 is constructed on breadboard. As the signal supply, analog signal generator is used for floating output.

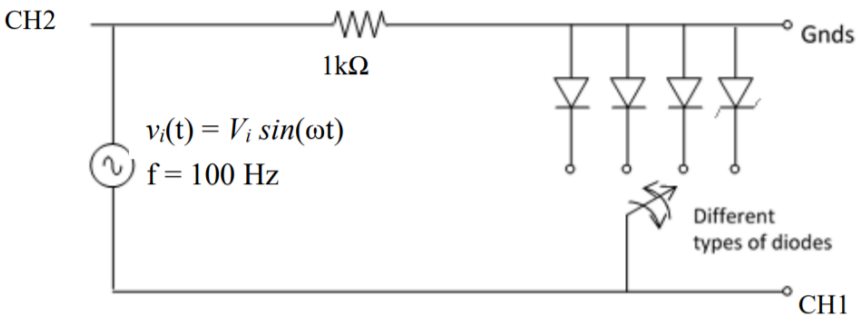

Figure 1: Circuit schematic for the step 1

2.1.1 a)

The diode models, AA119,BA159 ,and BZX55C-6V2 are used. The probes of the oscilloscope is connected to the nodes indicated in Figure 1. The resulting graph is plotted as given in Figure 2 , 3 ,and 4 for AA119,BA159 ,and BZX55C-6V2 respectively.

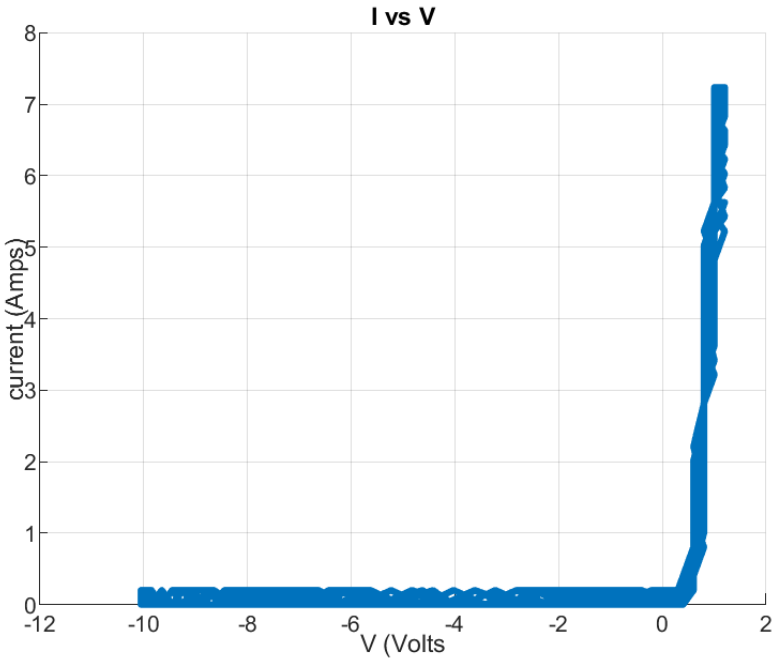

Figure 2: i-v characteristics of AA119

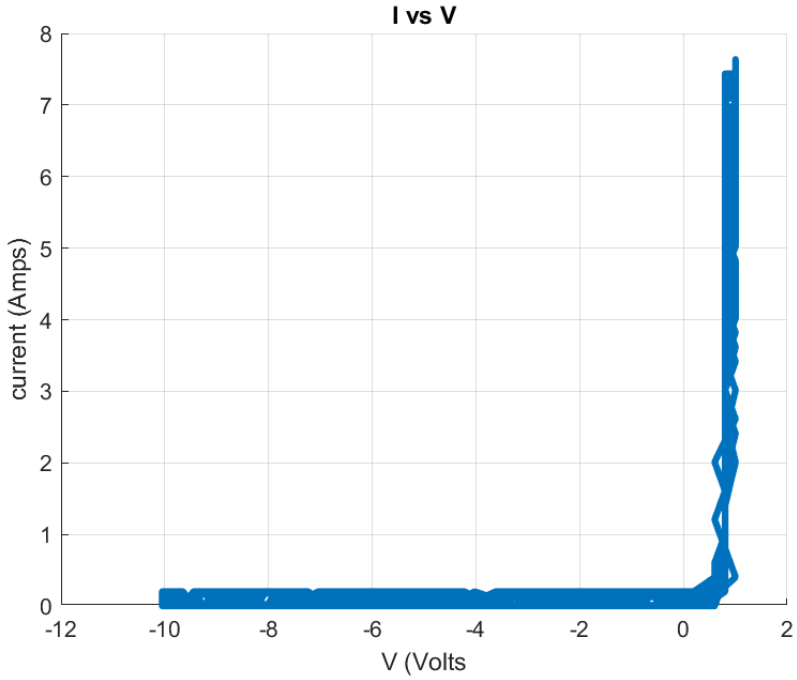

Figure 3: i-v characteristics of BA159

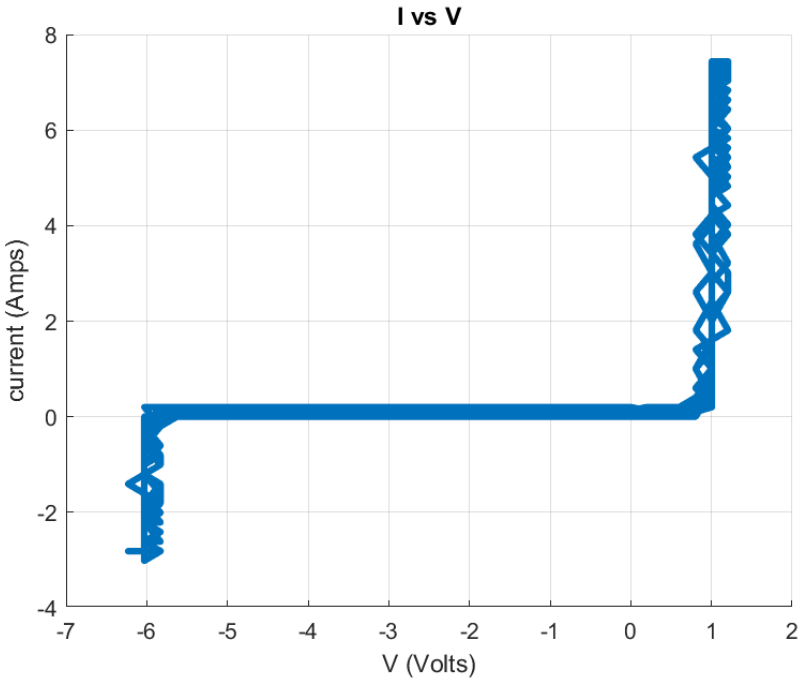

Figure 4: i-v characteristics of BZX55C-6V2

Using those plots the piecewise parameters of the diodes are obtained by the virtue of the cursors of the oscilloscope. The parameters of diode AA119 is given in Table 1.

Table 1: Piecewise parameters of diode AA119

V_{on}	350 mV
r_f	0.17 Ω
r_r	86 Ω

The obtained parameters of diode AA119 is given in Table 2.

Table 2: Piecewise parameters of diode BA159

V_{on}	973.5 mV
r_f	0.625 Ω
r_r	86.2 Ω

The obtained parameters of diode BZX55C-6V2 is given in Table 3.

Table 3: Piecewise parameters of diode BZX55C-6V2

V_{on}	752 mV
V_z	5.92V
r_f	0.05 Ω
r_r	0.156 Ω

So, the simple i-v characteristics of 3 different diodes are obtained ,and analyzed using the plot.

2.1.2 b)

In this part the frequency of the signal generator is adjusted and the i-v characteristics is observed again. The plot given in Figure 5 is obtained.

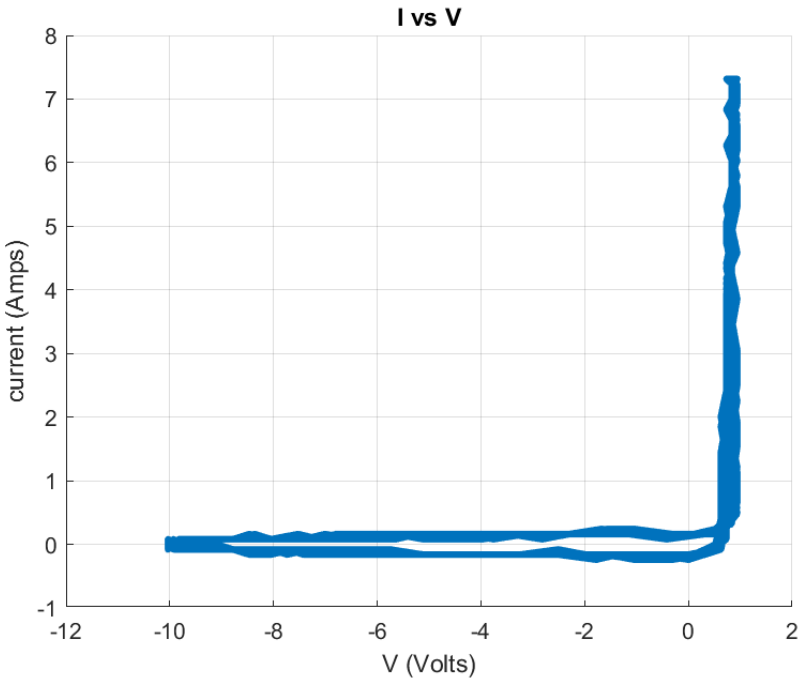

Figure 5: i-v characteristics of BA159 at 10khz

It can said that there is a slight seperation on horizontal lines in plot different than lower frequency plot. We can call separation of lines in this i-v graph as hysteresis effect. When we increase frequency to 10kHz, we observed hysteresis effect on the i-v characteristics of diode on the DSO screen. Since our diode can not change its state as fast as our high frequency voltage source supply, we observe this effect. To solve this problem and to be able to use diodes at high frequencies, there are "high speed" or "switching" diodes. These diodes can be used in high frequencies without observing hysteresis effect.

2.2 Step 2

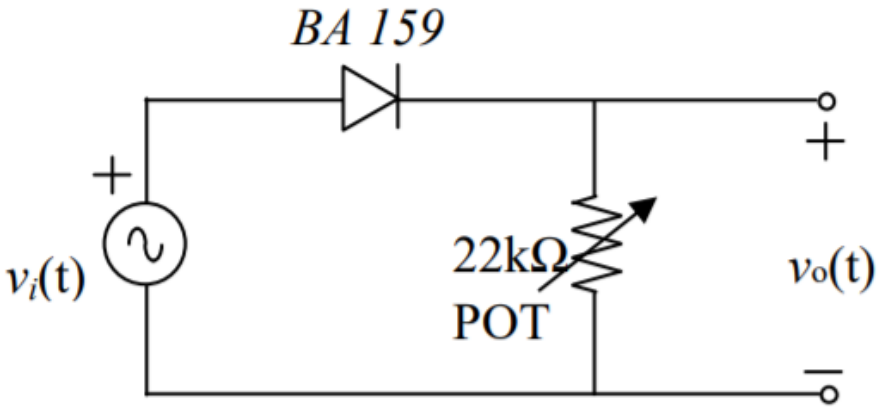

Figure 6: Circuit schematic for the step 2

For this part, we set the half-wave rectifier circuit given in Figure X and adjusted signal generator as $v_i(t) = 2sin(2000\pi t)V$

2.2.1 a)

POT is set to $1k\Omega$, and output and input voltage waveforms on the graph indicated in Figure 7 is obtained.

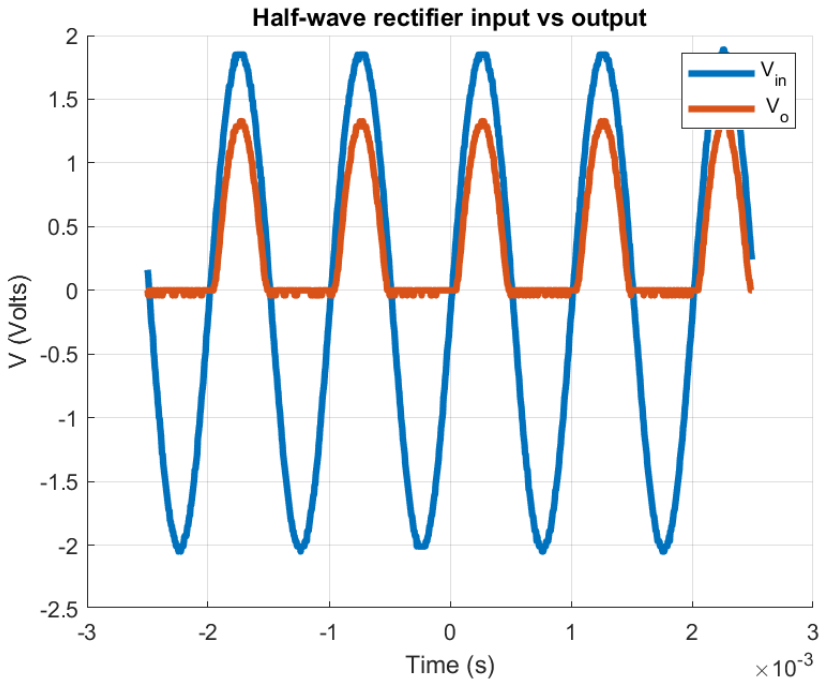

Figure 7: Half-wave rectifier with BA159

If one look at the graph carefully, it can be realized that output voltage is slightly lower than input voltage since diode consumes energy ,so has an internal resistance. Then we measured the DC_{rms} of output value as 730mV using cursors of DSO. Output voltage waveform on the DSO screen is in similar shape with the input waveform in positive cycles but zero when input is in the negative cycle.

2.2.2 b)

In this part in addition to the circuit given in Figure 6, a capacitor of 10μF is connected parallel to the potentiometer. Also the input signal is adjusted to $10sin(20\pi t)$. First POT is set to $10k\Omega$, and output and input voltage waveforms on the graph presented in Figure 8 is obtained.

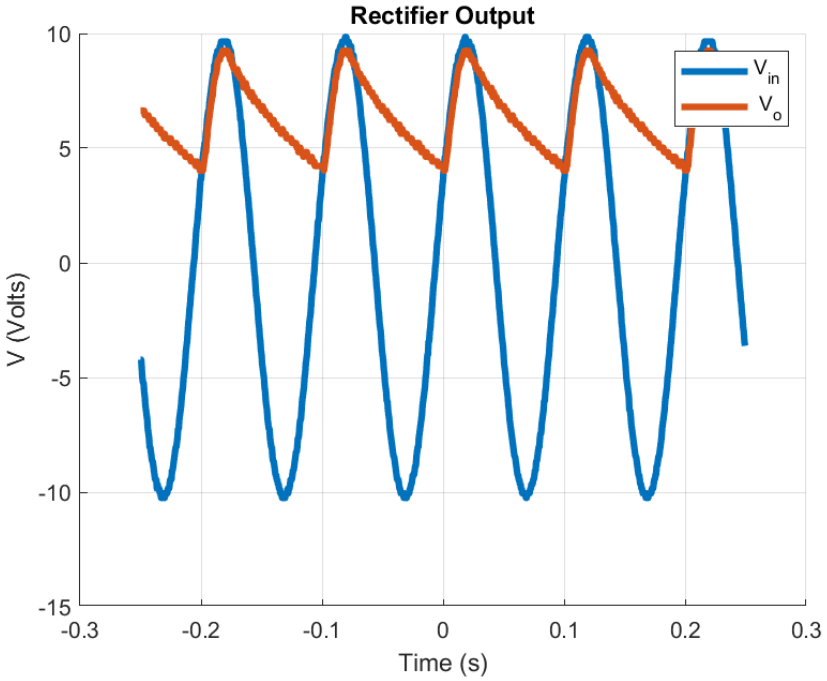

Figure 8: Half-wave rectifier with BA159 with pot set to 10K Ω

For this plot it can be said that because of the dischaging process of the capacitor the falling edge of output signal is different than the case without capacitor. The pot is adjusted to maximum (18KΩ) ,and the plot given in Figure 9 is obtained.

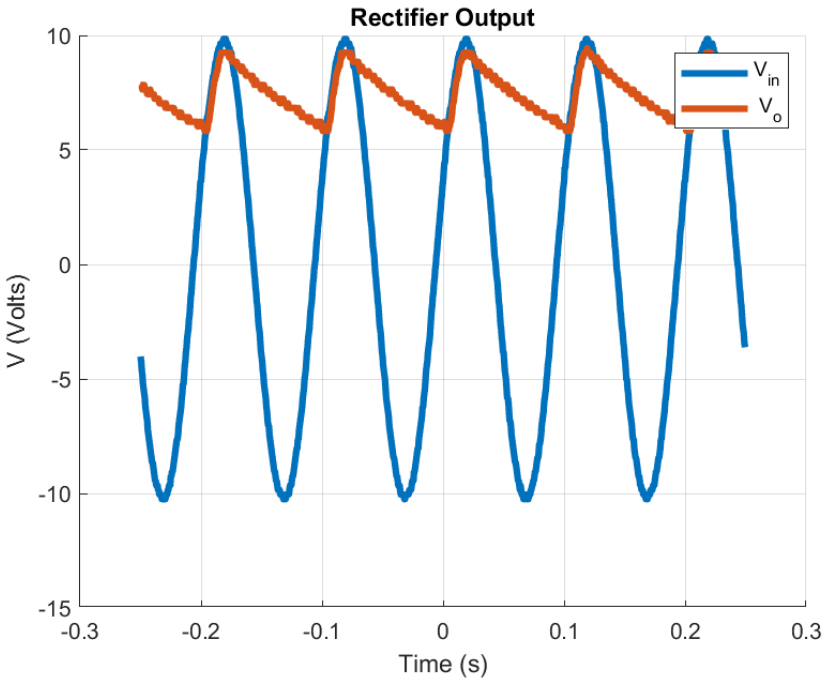

Figure 9: Half-wave rectifier with BA159 with pot set to 18K Ω

Here it can be said that ripple voltage is decreased as moved from 10KΩ. Lastly, the potentiometer is set to minimum (1.2KΩ). The plot given in Figure 10 is obtained.

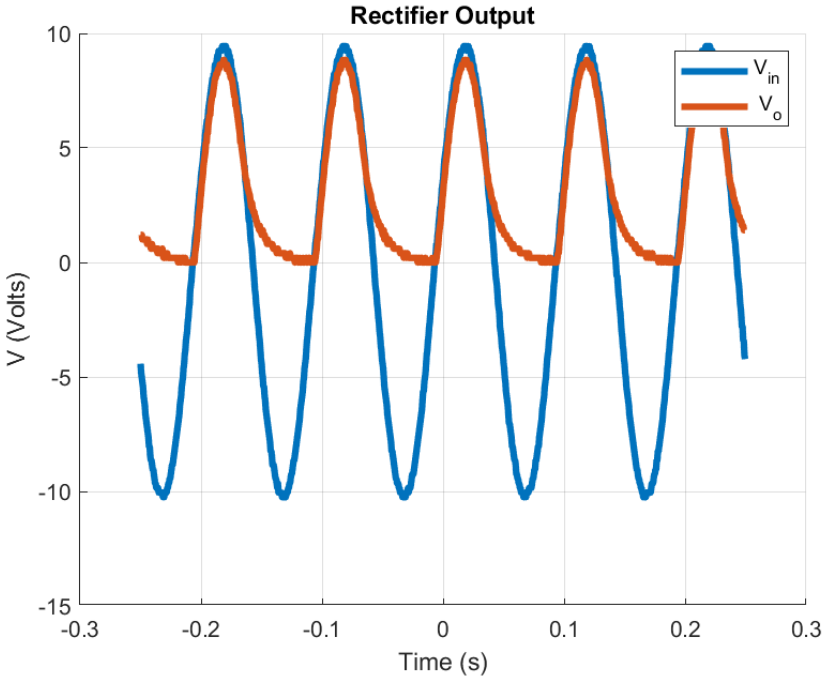

Figure 10: Half-wave rectifier with BA159 with pot set to 1.2K Ω

Here the ripple voltage is higher than other cases and equal to the case in which capacitor is absent.

As a result the V_{DC} , V_r values are recorded and given in Table 4.

Table 4: Piecewise parameters of diode BZX55C-6V2

R (Ohms)	C (mu Farads)	V_{DC} (Volts)	$V_{r,pp}$ (Volts)
10K	10	7.03	5.2
18K	10	6.93	4.8
1.2K	10	7.05	8.8

To decrease the ripple voltage in the case of constant resistance there are three options that can be done. First the capacitance of the capacitor can be increased so that it would take longer for resistor to consume its energy. Secondly, if the frequency of the input is inscreased the time interval of discharging is drops so ripple voltage may decrease. Lastly, even though it is not feasible ,a diode with a higher internal capacitance can be used to decrease ripple voltage.

2.3 Step 3

In this third step, we set up the diode clamper circuit given in Figure 11 using the diode 1N4001 and set the voltage $v_i(t) = 10sin(200\pi t)V$. Then plotted the input and output voltage waveforms on the graph given in Figure 12.

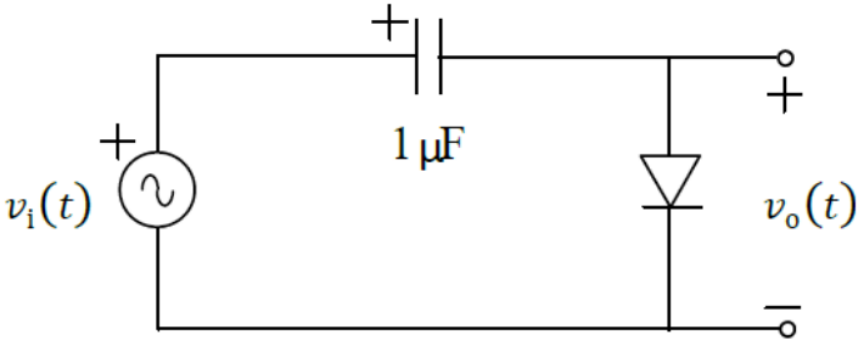

Figure 11: Circuit schematic for the step 3

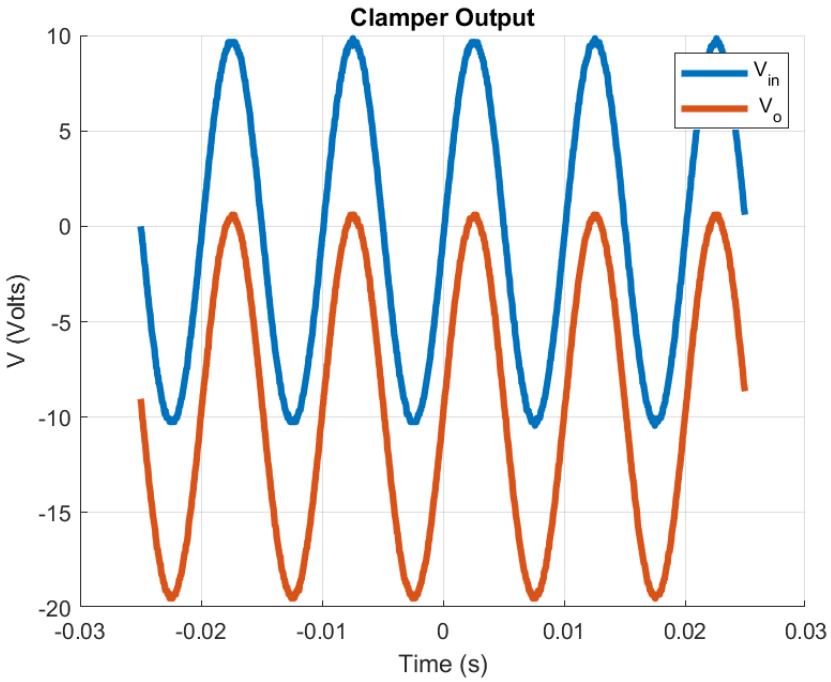

Figure 12: Clamper circuit output

From above graph we can derive that output waveform is just shifted form of input waveform to below zero. Since diode prevent capacitor from discharged, in order peak value of output to be clamped above zero diode should go into negative bias.

2.4 Step 4

In this last part, we set the circuit given in Figure 13 with the the load resistance ($100\Omega + 1k\Omega POT$) where R_L varies between 600-1100Ω. While we are changing potentiometer resistance from minimum to maximum (100 to 1000Ω), first output voltage has started to increase from 4V to 6V and then, We observed a constant output voltage of 6V even as we continue to increase R_L resistance. From these results, we can conclude that zener diode gives constant output in reverse bias high voltages hence, zener diode has a regulation effect.

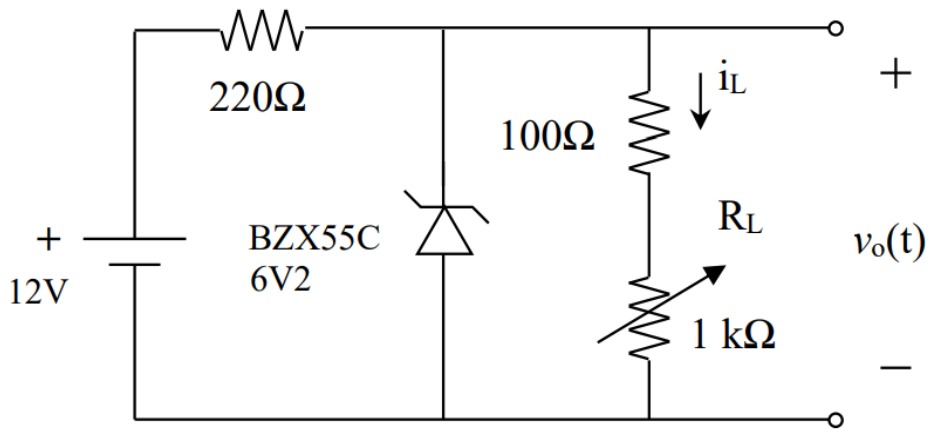

Figure 13: Circuit schematic for the step 4

3 Conclusion

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Appendix A

- PreLab Preprataion 6 hours
- Experimental Work 2 hours
- Report Writing 6 hours